SNAKE RIVER SOCKEYE SALMON CAPTIVE BROODSTOCK PROGRAM HATCHERY ELEMENT

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SNAKE RIVER SOCKEYE SALMON CAPTIVE BROODSTOCK PROGRAM HATCHERY ELEMENT

Project Progress Report

2001 Annual Report

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EXECUTIVE SUMMARY

On November 20, 1991, the National Marine Fisheries Service listed Snake River sockeye salmon *Oncorhynchus nerka* as endangered under the Endangered Species Act of 1973. In 1991, the Idaho Department of Fish and Game, the Shoshone-Bannock Tribes, and the National Marine Fisheries Service initiated efforts to conserve and rebuild populations in Idaho.

Initial steps to recover sockeye salmon included the establishment of a captive broodstock program at the Idaho Department of Fish and Game Eagle Fish Hatchery. Sockeye salmon broodstock and culture responsibilities are shared with the National Marine Fisheries Service at two locations adjacent to Puget Sound in Washington State. Activities conducted by the Shoshone-Bannock Tribes and the National Marine Fisheries Service are reported under separate cover. Idaho Department of Fish and Game monitoring and evaluation activities of captive broodstock program fish releases (annual report to the Bonneville Power Administration for the research element of the program) are also reported separately. Captive broodstock program activities conducted between January 1, 2001 and December 31, 2001 for the hatchery element of the program are presented in this report.

In 2001, 26 anadromous sockeye salmon returned to the Sawtooth Basin. Twenty-three of these adults were captured at adult weirs located on the upper Salmon River and on Redfish Lake Creek. Three of the anadromous sockeye salmon that returned were observed below the Sawtooth Fish Hatchery weir and allowed to migrate upstream volitionally (following the dismantling of the weir on October 12, 2001). Nine anadromous adults were incorporated into the captive broodstock program spawning design in 2001. The remaining adults were released to Redfish Lake for natural spawning. Based on their marks, returning adult sockeye salmon originated from a variety of release options.

Two sockeye salmon females from the anadromous group and 152 females from the brood year 1998 captive broodstock group were spawned at the Eagle Hatchery in 2001. Spawn pairings produced approximately 118,121 eyed-eggs with egg survival to eyed stage of development averaging 42.0%.

Presmolts (106,166), smolts (13,915), and adults (79) were planted or released into Stanley Basin waters in 2001. Supplementation strategies involved releases to Redfish Lake, Redfish Lake Creek, Alturas Lake, and Pettit Lake.

During this reporting period, five broodstocks and two unique production groups were in culture at Idaho Department of Fish and Game facilities (Eagle Fish Hatchery and Sawtooth Fish Hatchery). Two of the five broodstocks were incorporated into the 2001 spawning design, and one broodstock was terminated following the completion of spawning.

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INTRODUCTION

Numbers of Snake River sockeye salmon *Oncorhynchus nerka* have declined dramatically in recent years. In Idaho, only the lakes of the upper Salmon River (Stanley Basin) remain as potential sources of production (Figure 1). Historically, five Stanley Basin lakes (Redfish, Alturas, Pettit, Stanley, and Yellow Belly) supported sockeye salmon (Bjornn et al. 1968; Chapman et al. 1990). Currently, only Redfish Lake receives a remnant anadromous run.

On April 2, 1990, the National Marine Fisheries Service (NMFS) received a petition from the Shoshone-Bannock Tribes (SBT) to list Snake River sockeye salmon as endangered under the Endangered Species Act (ESA) of 1973. On November 20, 1991, NMFS declared Snake River sockeye salmon endangered.

The Idaho Department of Fish and Game (IDFG), as part of their five-year management plan, is charged with the responsibility of re-establishing sockeye salmon runs to historic areas, with emphasis placed on efforts to utilize Stanley Basin sockeye salmon and kokanee resources (IDFG 1996). In 1991, the SBT, along with the IDFG, initiated the Snake River Sockeye Salmon Sawtooth Valley Project (Sawtooth Valley Project) with funding from the Bonneville Power Administration (BPA). The goal of this program is to conserve and rebuild Snake River sockeye salmon populations in Idaho. Coordination of this effort is carried out under the guidance of the Stanley Basin Sockeye Technical Oversight Committee (SBSTOC), a team of biologists representing the agencies involved in the recovery and management of Snake River sockeye salmon. The NMFS ESA Permit Nos. 1120, 1124, and 1233 authorize IDFG to conduct scientific research on listed Snake River salmon.

Initial steps by IDFG to recover the species involved the establishment of captive broodstocks at the Eagle Fish Hatchery in Idaho and at NMFS facilities in Washington State (Flagg and McAuley 1994; Johnson 1993; Johnson and Pravecek 1995; Johnson and Pravecek 1996; Pravecek and Johnson 1997; Pravecek and Kline 1998; Kline and Heindel 1999; Kline and Willard 2000).

The participation of IDFG in the Sawtooth Valley Project falls under two general areas of effort: the sockeye salmon captive broodstock program (hatchery element) and Stanley Basin sockeye/kokanee monitoring and evaluation (research element). Activities associated with the captive broodstock program hatchery element are presented in this report.

PROGRAM GOALS

The ultimate goal of IDFG captive broodstock development efforts is to recover sockeye salmon runs in Idaho waters to self-sustaining levels that provide a degree of state and tribal harvest opportunity. The immediate project goal is to maintain this unique sockeye salmon population through captive broodstock technology and to avoid species extinction.

Objectives and Tasks

Objective 1. Develop captive broodstocks from Redfish Lake anadromous sockeye salmon. Culture broodstocks.

Task a. Maintain facilities to produce sockeye salmon captive broodstocks.

Task b. Modify facilities (e.g., wells, water delivery, buildings) to meet basic fish culture needs and safety concerns to satisfy Objective 1.

Task c. Use existing and emerging conservation hatchery technologies to develop, culture, and maintain sockeye salmon captive broodstocks.

Task d. Trap returning anadromous adults, juvenile out-migrants, and residual sockeye salmon to initiate broodstocks.

Task e. Collect samples for genetic analysis from all wild and hatchery-produced sockeye salmon. Transfer samples to NMFS and University of Idaho cooperators for analysis.

Task f. Incorporate wild and hatchery-produced fish in captive breeding design based on lineage and genetic identity.

Task g. Establish spawning matrices in consultation with NMFS and the program Technical Oversight Committee.

Task h. Spawn captive adults using a factorial design that follows the approved spawning design. Maximize genetic diversity whenever possible.

Task i. Produce genetically defined progeny (eyed-eggs, presmolts, smolts, and adults) for use in multiple release strategies to Stanley Basin lakes.

Task j. Produce genetically defined progeny to meet future broodstock spawning needs. Divide broodstock eggs between NMFS and IDFG facilities for rearing. Ship eggs and/or travel as needed to deliver eggs to NMFS facilities.

Task k. Produce "designer broodstocks" from cryopreserved milt to broaden the genetic base in future spawn years. Divide eggs between NMFS and IDFG facilities for rearing. Ship eggs and/or travel as needed to deliver eggs to NMFS facilities.

Task l. Cryopreserve milt from specific wild- and hatchery-produced sockeye salmon.

Task m. Conduct fertilization trials using cryopreserved milt from captive broodstock adults.

Task n. Maintain cryopreserved archives at three locations to spread the risk of loss from catastrophic events.

Task o. Monitor and adaptively manage hatchery outcomes related to fish survival, maturation rates, age-at-maturity, sex ratio, diet, and gamete quality of captive sockeye salmon.

Task p. Evaluate and adaptively manage time held on chilled water (maturing adults) in relation to gamete quality, fertilization rates, and anomalies in broodstock progeny.

Objective 2. Determine the contribution hatchery-produced sockeye salmon make toward recovery.

Task a. Maintain and operate juvenile and adult trapping facilities at the Sawtooth Hatchery and at lake outlet locations.

Task b. PIT tag wild- and hatchery-produced juveniles to facilitate evaluations of out-migration and adult return success by release location and strategy.

Task c. Differentially fin clip hatchery-produced juveniles to facilitate evaluations of out-migration and adult return success.

Task d. Estimate *O. nerka* out-migration from Stanley Basin lakes by release location and release strategy.

Task e. Evaluate out-migration success by release location and release strategy and adaptively manage the development of future release designs.

Task f. Develop estimates of travel time to lower Snake River hydropower projects and evaluate survival by release location and release strategy.

Task g. Identify spawning location and timing for prespawn adult sockeye released to lakes. Estimate spawning success.

Objective 3. Describe *O. nerka* population characteristics for Stanley Basin lakes in relation to carrying capacity and broodstock program release efforts.

Task a. Estimate *O. nerka* population variables by midwater trawl in four Stanley Basin lakes.

Task b. Trawl sufficiently to estimate abundance and density by age-class.

Task c. Collect scale and otolith samples from trawl captures for age and microchemistry analysis. Take tissue samples for genetic analysis. Take stomachs for diet analysis.

Task d. Develop lake carrying capacity estimates cooperatively with Shoshone-Bannock Tribes.

Task e. Monitor sport fisheries in sockeye salmon nursery lakes to determine their impact on recovery efforts (emphasis on kokanee harvest).

Objective 4. Determine the origin of wild and broodstock *O. nerka* to provide maximum effectiveness in their utilization within the broodstock program.

Task a. Use otolith microchemistry to identify the origin of *O. nerka* with unknown life histories.

Task b. Integrate microchemistry results with genetic information.

Objective 5. Technology Transfer.

Task a. Participate in the technical oversight committee process. Provide an adequate level of staffing at meetings to adequately present program information and to discuss program issues and challenges.

Task b. Network with technical experts on issues related to culture and broodstock techniques, genetics, pathology, and monitoring and evaluations.

Task c. Participate in essential program management and planning activities such as (but not limited to): budget meetings convened by the Columbia Basin Fish and Wildlife Authority, BPA, Idaho Office of Species Conservation, Northwest Power Planning Council, or National Oceanic and Atmospheric Administration fisheries; subbasin planning meetings; Artificial Production Review and Evaluation meetings; Safety Net and Artificial Production Program meetings; Hatchery and Genetic Management Plan meetings; and specific meetings considered essential to address comments and concerns of funding and review agencies such as the Northwest Power Planning Council and BPA.

Task d. Coordinate public information transfer with project cooperators.

Task e. Provide written activity reports to satisfy the needs and requirements of IDFG, the technical oversight committee, NMFS, and BPA.

METHODS

Fish Culture Facilities

Eagle Fish Hatchery

Eagle Fish Hatchery is the primary Idaho site for the sockeye salmon captive broodstock program. Artesian water from five wells is currently in use. Artesian flow is augmented with four separate pump/motor systems. Water temperature remains a constant 13.3°C, and total dissolved gas averages 100% after degassing. Water chilling capability was added at Eagle Fish Hatchery in 1994. Chiller capacity accommodates incubation, a portion of fry rearing, and a portion of adult holding needs. Backup and system redundancy is in place for degassing, pumping, and power generation. Nine water level alarms are in use, linked through an emergency service contractor. Additional security is provided by limiting public access and by the presence of three on-site residences occupied by IDFG hatchery personnel.

Facility layout at Eagle Fish Hatchery remains flexible to accommodate culture activities ranging from spawning and incubation through adult rearing. Egg incubation capacity at Eagle Fish Hatchery is approximately 180,000 eggs. Incubation is accomplished in small containers specifically designed for the program allowing for separation of individual subfamilies.

Incubators are designed to distribute both upwelling and downwelling flow to accommodate pre- and post-hatch life stages.

Several fiberglass tank sizes are used to culture sockeye from fry to the adult stage, including: 1) 0.7 m diameter semisquare tanks (0.09 m^3); 2) 1.0 m diameter semisquare tanks (0.30 m^3); 3) 2.0 m diameter semisquare tanks (1.42 m^3); 4) 3.0 m diameter circular tanks (6.50 m^3); and 5) 4.0 m diameter semisquare tanks (8.89 m^3). Typically, 0.7 m and 1.0 m tanks are used for rearing fry from ponding to approximately 1.0 g weight. Two- and three-meter tanks are used to rear juveniles to approximately 10.0 g and to depot and group fish by lineage or release strategy prior to distribution to Stanley Basin waters. Three- and four-meter tanks are used to rear fish to maturity for future broodstock production (spawning). Flows to all tanks are maintained at no less than 1.5 exchanges per hour. Shade covering (70%) and jump screens are used where appropriate. Discharge standpipes are external on all tanks and assembled in two sections ("half pipe principal") to prevent tank dewatering during tank cleaning.

Sawtooth Fish Hatchery

Sawtooth Fish Hatchery was completed in 1985 as part of the U.S. Fish and Wildlife Service Lower Snake River Compensation Plan and is located on the Salmon River, 3.5 km upstream from the confluence of Redfish Lake Creek. Sawtooth Fish Hatchery personnel and facilities have been utilized continuously since 1991 for various aspects of the sockeye captive broodstock program, including: 1) prespawn anadromous adult holding, 2) egg incubation, and 3) juvenile rearing for presmolt and smolt releases. In addition, hatchery personnel assist with many field activities, including: 1) net pen fish rearing; 2) fish trapping and handling; and 3) fish transportation and release.

Eyed-eggs, received at Sawtooth Fish Hatchery from Eagle Fish Hatchery or NMFS, are incubated in vertical trays. Fry are ponded to 0.7 m fiberglass tanks. Juvenile sockeye (>1 g) are held in vats or in a series of 2.0 m fiberglass tanks installed in 1997. Typically, juvenile sockeye salmon reared at Sawtooth Fish Hatchery are released as presmolts or smolts. Prespawn anadromous adults captured at Redfish Lake Creek or Sawtooth Fish Hatchery weirs are held in vats until release for natural spawning or transfer to the Eagle Fish Hatchery for spawning. Generally, well water supplies water flow for incubation, rearing, and holding. Well water temperature varies by time of year from approximately 2.5°C in January and February to 11.1°C in August and September. When sockeye salmon are held for smolt releases, they may be moved to outside raceways that receive water from the Salmon River. Salmon River water temperature varies by time of year from approximately 2.5°C in January and February to 13.3°C in August and September. Backup and redundancy water systems are in place. Rearing protocols are established cooperatively between IDFG personnel and reviewed at the SBSTOC level.

Fish Culture

Fish culture methods used in the captive broodstock program follow accepted standard practices (for an overview of standard methods, see Leitritz and Lewis 1976; Piper et al. 1982; Erdahl 1994; Bromage and Roberts 1995; McDaniel et al. 1994; Pennell and Barton 1996). Considerable coordination takes place between NMFS and IDFG culture experts and at the SBSTOC level.

Fish are fed a commercial diet produced by Bio-Oregon, Inc. (Warrenton, Oregon). Through approximately 150.0 g weight, fish receive a standard Bio-Oregon semimoist formulation. Rations are weighed daily and follow suggested feeding rates provided by the manufacturer. Bio-Oregon developed a custom broodstock diet that includes elevated levels of vitamins, minerals, and pigments. Palatability and levels of natural pigments are enhanced by the addition of natural flavors from fish and krill. Beyond 150.0 g weight, fish receive the Bio-Oregon custom broodstock diet.

Fish sample counts are conducted as needed to ensure that actual growth tracks with projected growth. In general, fish are handled as little as possible. Age-1 and age-2 sockeye salmon rearing densities are maintained at levels not to exceed 8.0 kg/m^3. Age-3 and age-4 rearing densities are maintained at levels not to exceed 14.0 kg/ m^3.

Incubation and rearing water temperature is maintained between 10.0°C and 13.3°C. Chilled water (9.0°C to 11.0°C) may be used during incubation and early rearing to equalize development and growth differences that may result from a protracted spawning period. Sockeye salmon greater than age-1 are generally maintained on chilled water. Rearing water temperature varies as a function of demand but is generally maintained between 10.0°C and 12.0°C.

Passive integrated transponder tags (PIT tags) are used to evaluate the overwinter survival and out-migration success of production groups released to Stanley Basin waters. These PIT tags are also used to track sockeye salmon retained in the program as broodstock fish. Production and broodstock sockeye salmon are PIT tagged at approximately six months of age. The PIT tag procedures follow accepted, regional protocols (Prentice et al. 1990).

Chemical therapeutants are used prophylactically and for the treatment of infectious diseases. Before initiating treatments, the use of chemical therapeutants is discussed with an IDFG fish health professional. Fish necropsies are performed on all program mortalities that satisfy minimum size criteria for the various diagnostic or inspection procedures performed. Carcasses are either incinerated, land filled, or rendered.

Net Pen Culture

In 1994, the SBSTOC initiated net pen culture in Redfish Lake in an attempt to duplicate the successes observed with this technique in other Pacific Northwest sockeye salmon culture programs (Petersen et al. 1997). Four net pens are anchored in approximately 23.0 meters of water approximately 200.0 meters from the northwest shore of Redfish Lake and approximately 2.0 km west of the marina. The net pen structure consists of four 4.9 m square by 13.7 m deep nets that are suspended by four 6.0 m square frames constructed of untreated wood walkways and galvanized steel with encased styrofoam. The frames are connected and held in a square formation. Fish are transported to the net pens in early summer and released from the net pens in the fall. Personnel utilize SCUBA to monitor net pens monthly for damage to the nets and to collect any mortalities settled at the bottom of the nets. Dissolved oxygen, temperature, and Secchi disc measurements are collected weekly. Automatic feeders provide fish with rations of Bio-Oregon. Rations are weighed daily and follow suggested feeding rates provided by the manufacturer.

Anadromous and Residual Adult Sockeye Salmon Trapping

Two adult traps are used to capture returning anadromous sockeye salmon in the Sawtooth Basin. The first trap is located on Redfish Lake Creek approximately 1.4 km downstream from the lake outlet. The second trap is located on the upper Salmon River at the Sawtooth Fish Hatchery weir.

A floating Merwin trap is used to capture residual sockeye salmon adults in Redfish Lake when they are incorporated into the captive broodstock program. When used, the trap is installed in October on the west side of the lake at the north end of Sockeye Beach.

Spawning Activities

Spawning has occurred at Eagle Fish Hatchery each year since 1994 (Johnson 1993). Before 1994, adult sockeye returns were spawned at the Sawtooth Fish Hatchery (Johnson and Pravecek 1995; Johnson and Pravecek 1996; Kline and Heindel 1999; Kline and Willard 2000). Spawning follows accepted standard practices as described by McDaniel et al. (1994) and Erdahl (1994). The IDFG is required by NMFS Permit No. 1120 to discuss proposed broodstock spawning matrices before conducting activities (Appendix A). In general, spawning designs are developed to maximize genetic diversity in resultant progeny and to minimize inbreeding risks. Eggs produced at spawning are typically divided into three lots (by female) and fertilized with sperm from three males (factorial design). Male contribution is subsequently equalized as each male is used to fertilize eggs from three different females (on average). Eggs are incubated by lot on different water temperatures to yield lineage-specific size groups for supplementation under different strategies and to produce fish to meet future broodstock needs.

Milt Cryopreservation

Cryopreservation of milt from male donors has been conducted in the captive broodstock program since 1991 and follows techniques described by Cloud et al. (1990) and Wheeler and Thorgaard (1991). Beginning in 1996, cryopreserved milt was used to produce specific lineage broodstocks for use in future spawn years. “Designer broodstocks” produced in this manner will increase the genetic variability available in future brood years.

Fish Health Investigations

The Eagle Fish Health Laboratory operated by IDFG processes samples for diagnostic and inspection purposes from captive broodstock sockeye salmon, production sockeye salmon, and anadromous sockeye salmon. Routine fish necropsies include investigations for viral pathogens (infectious pancreatic necrosis virus and infectious hematopoietic necrosis virus) and various bacterial pathogens (e.g., bacterial kidney disease *Renibacterium salmoninarum*, bacterial gill disease *Flavobacterium branchiophilum*, coldwater disease *Flavobacterium psychrophilum*, and motile aeromonad septicemia *Aeromonas* spp.). In addition to the above, anadromous adult sockeye salmon are screened for the causative agent of whirling disease *Myxobolus cerebralis*, furunculous *Aeromonas salmonicida*, and the North American strain of viral hemorrhagic septicemia virus. All laboratory diagnostic and inspection procedures follow protocols described by Thoesen (1994).

Juvenile Fish Quality Assessment

In 1999, the SBSTOC recommended applying assessments of fish quality to juvenile sockeye salmon produced in this program to provide additional perspective on factors that may affect fish survival from outplanting through out-migration. General parameters considered for investigation included: 1) proximate body composition analysis, 2) organosomatic index, and 3) fish health. Only proximate body composition was investigated in 2001.

To determine proximate body composition, sampled fish were dried, ground, and analyzed using standardized methods for proximate composition from the Association of Official Analytical Chemists (AOAC) (1990). Sample protein content was analyzed using a LECO FP 28 nitrogen analyzer. Crude lipid content in samples was analyzed using a LECO TFE 2000 super-critical CO^2 extractor (both are from LECO Corp., St. Joseph, Missouri).

Eyed-Egg and Fish Transfers

Eggs are shipped at the eyed stage between NMFS and IDFG facilities using a commercial air service. Iodophor-disinfected (100 ppm) eggs are packed at a conservative density in perforated tubes, then capped and labeled. Tubes are wrapped with hatchery water-saturated cheesecloth and packed in small coolers. Ice chips are added to ensure proper temperature maintenance, and coolers are sealed with packing tape. Personnel from IDFG and NMFS are responsible for shuttling coolers to air terminals.

Fry may be transferred between IDFG and NMFS facilities. If fry transfers occur, a commercial air service is used as described above. Fish are transported in plastic fish transfer bags containing 10°C water. Oxygen is added to the bags before sealing. Bags are placed in coolers containing ice chips to ensure an appropriate temperature environment. Coolers are sealed with packing tape and accompanied by IDFG personnel on the aircraft.

Containers used to transport fish vary by task. In all cases, containers of the proper size and configuration are used. Appropriate temperature, oxygen, and chemical composition are maintained during the handling and transfer phases of transportation. Containers vary from five-gallon plastic buckets and coolers for short-term holding and inventory needs to barge-mounted holding tanks for mid-lake (pelagic) fish releases and net pen fish transfers. Truck-mounted tanks, used for long distance transfers, are available to the program with 300 gal (1,136 L), 1000 gal (3,785 L), and 2,500 gal (9,463 L) capacities. Transport guidelines are in place to not exceed 89 g/L (0.75 lb/gal).

Eyed-Egg and Fish Supplementation

Sockeye salmon have been reintroduced to Stanley Basin waters as eyed-eggs, subyearlings, yearlings, and prespawn adults.

Eyed-eggs are distributed to egg boxes manufactured by IDFG personnel specifically for this program. Plastic light baffle grids and plastic mesh netting partition and prevent eggs from falling into the biofilter ring medium until after hatch. Plastic mesh netting surrounding egg boxes allows fish to volitionally emigrate following yolk absorption. Each egg box accommodates approximately 5,000 eggs. Following loading, egg boxes are lowered to the lake substrate in approximately 3 m of water over known or suspected areas of lakeshore spawning.

Sockeye salmon presmolts are distributed to Stanley Basin lakes in truck-mounted transportation tanks. Fish are transferred from truck-mounted tanks to 250 gal (946 L) barge-mounted tanks for pelagic releases and net pen introductions. Adequate water temperature tempering occurs before the release of fish.

Sockeye salmon smolts are distributed to Stanley Basin waters using truck-mounted transportation tanks. To date, sockeye salmon smolts have only been introduced to the outlet of Redfish Lake Creek downstream of the juvenile out-migrant weir and to the Salmon River downstream of the Sawtooth Fish Hatchery weir. Adequate water temperature tempering occurs before the release of fish.

Prespawn adult sockeye salmon are distributed to Stanley Basin waters using truck-mounted transportation tanks. Adults have been introduced to Redfish Lake, Alturas Lake, and Pettit Lake. Fish are released at public access points at dusk. Adequate water temperature tempering occurs before the release of fish.

RESULTS AND DISCUSSION

Fish Culture

During this reporting period, five broodstock and two production groups were in culture at IDFG facilities representing brood years 1997, 1998, 1999, 2000, and 2001. A summary of losses while in culture during this reporting period is presented in Tables 1 and 2. Culture groups developed to meet future spawning needs are designated as “broodstock” groups. Culture groups developed primarily for reintroduction to Sawtooth Basin waters are designated as “production” groups. The year of development for specific culture groups may appear abbreviated (e.g., BY96 refers to brood year 1996).

BY97 Broodstock

This group consists of progeny from ANBY94 females and cryopreserved milt from 1991 Redfish Lake out-migrant males (OM91), 1992 Redfish Lake out-migrant males (OM92), and the single male sockeye salmon that returned to Redfish Lake in 1992 (AN92). Initial inventory for BY97 broodstock was 12 fish. Eleven fish matured in 2001; none of the BY97 fish were utilized in spawn crosses. At the end of the reporting period, zero fish from this broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY98 Broodstock

Three primary culture groups were developed in 1998 to meet future broodstock needs. The first group (produced at the Big Beef Creek Hatchery and transferred to the Eagle Fish Hatchery in November 1998) was developed from second generation females (ANBY91) produced from the four anadromous adults that returned to Redfish Lake Creek in 1991 (AN91) and the single anadromous male that returned to Redfish Lake Creek in 1998 (AN98). The second culture group was developed from first generation females (ANBY96) produced from the single female that returned to Redfish Lake Creek in 1996 (AN96). Males used for spawn crosses included first generation males (ANBY94) produced from the single female that

returned to Redfish Lake Creek in 1994 (AN94), the single anadromous male that returned to Redfish Lake Creek in 1998 (AN98), and cryopreserved milt from first generation progeny (OMBY93) of female 1991 Redfish Lake out-migrants (OM91) and the six male sockeye salmon that returned to Redfish Lake Creek in 1993 (AN93). The third culture group was developed from first generation females and males (ANBY96) produced from the single female that returned to Redfish Lake Creek in 1996 (AN96). All fish were combined post PIT tagging and reared collectively as BY98 sockeye salmon broodstock. Initial inventory for this reporting period was 278 fish. One hundred fifty-two females and 90 males matured at age-3 in 2001. One hundred twenty-nine females and nine males were utilized in hatchery spawn crosses. At the end of this reporting period, 23 BY98 broodstock remained in culture at the Eagle Fish Hatchery (Table 1).

BY99 Broodstock

Eleven families, represented by 30 unique subfamilies, were developed from brood year 1999 broodstock spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two broodstock group titles: BY99 and ANHBY99. The BY99 broodstock group was developed using male and female sockeye salmon from the ANBY96, BY96, and BY97 broodstocks (described above). Specific crosses performed to develop this broodstock group included: 1) ANBY96 females x BY97 males, 2) ANBY96 females x ANBY96 males, 3) ANBY96 females x BY96 males, 4) BY96 females x ANBY96 males, and 5) BY96 females x BY97 males. The ANHBY99 broodstock group was developed using male and female sockeye salmon from ANBY96, BY96, BY97 broodstocks and four of the seven anadromous adults that returned to the Sawtooth Fish Hatchery in 1999 (ANH99). Specific crosses performed to develop this broodstock group included: 1) ANBY96 females x ANH99 males, 2) BY96 females x ANH99 males, 3) ANH99 female x ANBY96 males, 4) ANH99 female x BY96 males, 5) ANH99 female x BY97 males, and 6) ANH99 female x cryopreserved milt from the single male sockeye salmon that returned to Redfish Lake Creek in 1998 (AN98). Initial inventory for this reporting period was 377 fish. Seventy-five males matured at age-2 in 2001; 56 were utilized in hatchery spawn crosses. At the end of this reporting period, 271 BY99 fish remained in culture at the Eagle Fish Hatchery (Table 1).

BY00 Production

Sixteen families, represented by 49 unique subfamilies, were developed from brood year 2000 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two production group titles: BY00 and ANHBY00. The BY00 production group was developed using male and female sockeye salmon from the BY97 and BY98 broodstocks (described above). Specific crosses performed to develop this production group included: 1) BY97 females x BY97 males, 2) BY97 females x BY98 males, and 3) BY98 females x BY97 males. Approximately 170,419 eyed-eggs were produced from BY00 spawn crosses. The ANHBY00 production group was developed using male and female sockeye salmon from BY97 and BY98 broodstocks and 38 (18 females and 20 males) of the 41 anadromous adults that returned to the Stanley Basin in 2000 and were retained for spawning. Specific crosses performed to develop this production group included: 1) ANH00 females x BY97 males, 2) ANH00 females x BY98 males, 3) ANH00 females x ANH00 males, and 4) BY97 females x ANH00 males. Initial inventory of developing fry and eggs for this reporting period included approximately 110,641 at Sawtooth Fish Hatchery and 62,554 at Eagle Fish Hatchery.

On July 27, 2001, 6,123 age-0 presmolts from this production group were released to Alturas (3,064) and Pettit (3,059) lakes. On July 31, 2001, an additional 3,357 age-0 presmolts from this production group were released to Alturas (3,059) and Pettit (2,998) lakes. As part of the fall direct release strategy, 52,512 age-0 presmolts were released to Alturas (5,990), Pettit (4,993), and Redfish (41,529) lakes on October 8 and 9, 2001. On June 18, 19, and 21, 2001, 49,090 BY00 presmolts were transferred from Eagle Fish Hatchery to net pens in Redfish Lake; 41,474 presmolts were released from the net pens on October 10, 2001. At the end of this reporting period, 38,851 fish from this production group remained in culture at the Sawtooth Fish Hatchery (Table 2). These fish are scheduled for direct release as smolts in May of 2002.

BY00 Broodstock

Approximately 900 eyed-eggs were segregated from production groups described above to create the BY00 broodstock representing ten families (54 unique subfamilies). Approximately 346 eyed-eggs and 42 fry were transferred to NMFS facilities, where they will remain through maturation. The majority of BY00 broodstock adults produced at NMFS facilities will contribute to future spawning designs. Inventory reporting for these fish will appear separately by NMFS. Initial inventory for the BY00 broodstock at Eagle Fish Hatchery was 515 developing fry. At the end of this reporting period, 472 BY00 broodstock fish were in culture (Table 1).

BY01 Production

Sixteen families, represented by 86 unique subfamilies, were developed from brood year 2001 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two production group titles: BY01 and ANHBY01. The BY01 production group was developed using male and female sockeye salmon from the BY98 and BY99 broodstocks (described above). Specific crosses performed to develop this production group included: 1) BY98 females x BY99 males and 2) BY98 females x BY98 males. Approximately 95,209 eyed-eggs were produced from BY01 spawn crosses. The ANHBY01 production group was developed using male and female sockeye salmon from the BY98 broodstock, male sockeye salmon from the BY99 broodstock and nine (two females and seven males) of the 26 anadromous adults that returned to the Stanley Basin in 2001 and were retained for spawning. Specific crosses performed to develop this production group included: 1) ANH01 females x BY98 males, 2) ANH01 females x BY99 males, and 3) BY98 females x ANH01 males. Approximately 23,092 eyed-eggs were produced from ANHBY01 spawn crosses. Eagle Fish Hatchery transferred 116,600 BY01/ANHBY01 production eggs to the Sawtooth Fish Hatchery in November 2001. At the end of this reporting period, approximately 116,600 eyed eggs were in culture at Sawtooth Fish Hatchery (Table 2). Eyed-eggs produced from NMFS production crosses in 2001 (approximately 90,222) were transferred to the Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery to be reared as smolts for this program. National Marine Fisheries Service activities will be reported separately by that agency.

BY01 Broodstock

Approximately 870 eyed-eggs were segregated from production groups described above to create the BY01 broodstock representing 11 families (50 unique subfamilies). Approximately 435 eyed-eggs were transferred to NMFS facilities, where they will remain through maturation. The majority of BY01 broodstock adults produced at NMFS facilities will contribute to future

spawning designs. Inventory reporting for these fish will appear separately by NMFS. At the end of this reporting period, 435 developing fry were in culture at Eagle Fish Hatchery (Table 1).

Anadromous and Residual Sockeye Salmon Trapping

Two adult traps capture returning anadromous sockeye salmon in the Sawtooth Basin. The first trap is located on Redfish Lake Creek approximately 1.4 km downstream from the lake outlet and was operated from June 25 to October 12, 2001. The second trap is located on the upper Salmon River at the Sawtooth Fish Hatchery weir and was operated from May 24 to October 12, 2001.

In 2001, 26 anadromous sockeye salmon returned to the Sawtooth Basin. Traps on Redfish Lake Creek and the upper Salmon River at the Sawtooth Fish Hatchery intercepted 15 and 8 adults, respectively. Additionally, three adult sockeye salmon were observed immediately downstream of the Sawtooth Fish Hatchery trap but were not handled. Fish were captured between July 23 and October 3, 2001. Returning adult sockeye salmon originated from a variety of release options, including: 1) 1998 smolt release in Redfish Lake Creek, 2) 1998 presmolt releases in Redfish, Alturas, and Pettit lakes, 3) 1999 smolt releases in Redfish Lake Creek and the upper Salmon River, and 4) 1997 eyed-egg releases and prespawn adult releases in Redfish Lake. With the exception of out-migrants originating from prespawn adult and eyed-egg releases, all juveniles released in 1998 and 1999 were adipose fin-clipped. A portion of fish released as presmolts and smolts were also PIT tagged. Additionally, fish released as smolts and reared at the Bonneville Fish Hatchery were left ventral fin-clipped and coded wire-tagged. A summary of adult returns is presented in Table 3.

One adult chinook salmon *O. tshawytscha* female was captured at the Redfish Lake Creek trap and passed upstream.

2001 Production Spawning

The IDFG is required by Permit No. 1120 to discuss proposed broodstock spawning matrices with NMFS Northwest Fisheries Science Center (NWFSC) genetics staff. In 2001, this was accomplished by distributing and discussing a proposed spawning matrix at the SBSTOC held on October 2, 2001 in Manchester, Washington (Appendix A). Representatives from NMFS Conservation Biology and Resource Enhancement and Utilization Technologies divisions (NWFSC) were present at this meeting. No objections to the proposed spawning design were aired. During the fall of 2001, 242 age-3 fish (152 females and 90 males) from the BY98 broodstock and 75 age-2 fish (all males) from the BY99 broodstock matured at the Eagle Fish Hatchery. In addition to these maturing broodstocks, nine (two females and seven males) of the 26 anadromous adults (ANH01) that returned to the Stanley Basin in 2001 were transferred to the Eagle Fish Hatchery and incorporated into the spawning design. Eggs from crosses performed with anadromous adults contributed to both production and broodstock program needs.

One hundred thirty-one females and 72 males were spawned at Eagle Fish Hatchery between October 5 and November 7, 2001 to generate 282,434 green and 118,121 eyed-eggs. Brood year 1998 female fecundity averaged 2,213 eggs. Egg survival to the eyed stage of development for the BY01 production group averaged 40.7% (median 31.7%) (Table 4).

To avoid inbreeding, an effort was made to outcross fish from different brood years (e.g., BY96 females spawned with BY97 males and BY96 anadromous males). When this was not possible, within brood year spawn crosses were made based on a desirability matrix designed to avoid or minimize inbreeding.

Sixteen families, represented by 86 unique subfamilies, were developed from brood year 2001 production spawn crosses at the Eagle Fish Hatchery. To simplify tracking, families were grouped under two production group titles: BY01 and ANHBY01. The BY01 production group was developed using male and female sockeye salmon from the BY98 broodstock and male sockeye salmon from the BY99 broodstock. Specific crosses performed to develop this production group included: 1) BY98 females x BY99 males, and 2) BY98 females x BY98 males.

The ANHBY01 production group was developed using male and female sockeye salmon from the BY98 broodstock, male sockeye salmon from the BY99 broodstock, and nine (two females and seven males) of the 26 anadromous adults that returned to the Stanley Basin in 2001 and were retained for spawning. Specific crosses performed to develop this production group included: 1) ANH01 females x BY98 males, 2) ANH01 females x BY99 males, and 3) BY98 females x ANH01 males. Spawn crosses produced approximately 48,407 green and 23,092 eyed-eggs. Fecundity for ANH01 females averaged 2,743 eggs. Egg survival to the eyed stage of development for the ANHBY01 production group averaged 47.7% (median 55.8%) (Table 4).

2001 BROODSTOCK SPAWNING

Approximately 870 eyed-eggs representing 11 unique families (50 subfamilies) were selected from specific spawn crosses described above and incubated separately to meet future broodstock needs. Approximately 50% of these eggs were transferred to NMFS to source their BY01 broodstock group. Spawn crosses represented in IDFG and NMFS broodstock groups are presented in Table 5.

Milt Cryopreservation

In 2001, no milt from maturing sockeye salmon was cryopreserved, and no crosses were performed utilizing cryopreserved milt.

Fish Health Investigations

The IDFG Eagle Fish Health Laboratory processed samples for diagnostic and inspection purposes from broodstock and production groups of sockeye salmon, anadromous adult sockeye salmon that were retained for hatchery spawning, sockeye salmon smolts obtained from out-migrant traps, and kokanee obtained from trawl efforts. Eighty-one laboratory cases involving 386 individual fish were processed in 2001. The laboratory also summarized pathology findings to satisfy the needs of adjacent state agencies for issuance of sockeye salmon import and transport permits.

There was no evidence of viral pathogens in any of the production and broodstock groups in 2001. This result is consistent with results from previous years. In addition, no viral pathogens were detected in the nine anadromous adults examined in 2001. The Redfish Lake

population remains the only sockeye salmon population in the Pacific Northwest that does not have infectious hematopoietic necrosis virus.

Clinical bacterial kidney disease (BKD), caused by *Renibacterium salmoninarum*, did not occur in any production groups of sockeye salmon juveniles reared at Eagle Fish Hatchery or Sawtooth Fish Hatchery. Two cases from Sawtooth Fish Hatchery demonstrated elevated ELISA OD values; however, the levels did not indicate a clinical disease. Captive adult sockeye salmon spawned in 2001 were also free of clinical levels of BKD. Bacterial kidney disease antigen was detected in two (both males) of the nine anadromous adults examined in 2001. Bacterial kidney disease antigen was also detected in one of ten smolt samples collected during emigration from Alturas Lake. Bacterial kidney disease was not detected at Pettit or Redfish Lake trapping locations.

No furunculosis, caused by *Aeromonas salmonicida*, was detected in any of the anadromous adults retained for spawning. However, as a precaution, we administered intraperitoneal injections of both Oxytetracycline and erythromycin shortly after the adults were trapped.

Clinical disease caused by motile *Aeromonas spp.* was present in both anadromous adults, captive reared adults, and in BY99 and BY00 production sockeye salmon. Antibiotic therapy was administered three times in 2001 to control losses in captive reared adults and production groups. Myxobacteria infections (cold water disease and columnaris) were detected in the net pen reared fish and treated with antibiotics.

The Myxosporean parasite, *Myxobolus cerebralis,* which can cause salmonid whirling disease, is present in the upper Salmon River. The Eagle Fish Health Laboratory demonstrated the seasonal infectivity in the river water supply of the Sawtooth Fish Hatchery using sentinel rainbow trout fry. Infection of this parasite was detected all months except January and February. In addition, two groups of sockeye salmon fingerlings were exposed as part of this study to examine relative susceptibility to the disease. These exposures resulted in a low prevalence of infection and were used to evaluate the risk of rearing sockeye salmon on river water during the winter months. In 2001, eight anadromous adults were examined for presence of the parasite. Sixty-two percent (five fish) of these adults were positive for *M*. *cerebralis*. Sockeye salmon have been reared almost exclusively on pathogen free well water at the Sawtooth Fish Hatchery; this suggests that smolts are being infected during seaward migration. In addition, since the inception of this project in 1991, *M. cerebralis* has not been identified in juveniles emigrating from Redfish, Pettit, or Alturas lakes. Kokanee present in these lakes also tested negative.

In 2001, the nine anadromous adults were examined for the presence of *Piscirickettsia salmonis.* All the results were negative, indicating that this emerging pathogen has not become established in Idaho.

One neoplasm, thymic lymphosarcoma, was observed in one BY98 sockeye salmon. Thymic lymphosarcomas have been observed in past years at the Eagle Fish Hatchery. Slides and tissues of this tumor were deposited and cataloged in the National Registry of Tumors of Lower Vertebrates at George Washington University Medical Center, an arm of the Smithsonian Institute.

Kokanee obtained by trawling in Redfish, Pettit, and Alturas lakes were shown to be negative for viral pathogens, BKD, and *M. cerebralis.*

Juvenile Fish Quality Assessment

In 2001, the following groups of fish were sampled for proximate body composition analysis: 1) hatchery-produced out-migrants from Redfish, Pettit, and Alturas lakes (primarily brood year 1999), 2) wild/natural out-migrants from Alturas Lake, 3) brood year 2000 hatchery-produced presmolts at Eagle and Sawtooth fish hatcheries, 4) brood year 2000 Redfish Lake net-pen fish, and 4) kokanee trawl samples from Redfish, Alturas, and Pettit lakes and kokanee hook and line samples from Redfish and Alturas lakes (Table 6).

Proximate analysis data identified that Pettit Lake out-migrants exhibited greater mean percent fat dry weight (% fat) than Alturas and Redfish lake out-migrants. Year 2001 out-migrants from Pettit Lake exhibited mean % fat levels of 2.6% (±1.2%), 6.8% (±1.5%), and 5.9% (±1.2%) for Eagle-reared fish planted as presmolts on July 31, 2000, Sawtooth-reared presmolts planted on July 31, 2000, and Sawtooth-reared presmolts planted on October 11, 2000, respectively. Eagle-reared fish planted as presmolts in July, Sawtooth-reared fish planted as presmolts in July, and Sawtooth-reared fish planted as presmolts in October averaged 15.2 g, 18.9 g, and 19.8 g, respectively, when captured and sampled in May 2001.

Year 2001 out-migrants from Alturas Lake exhibited mean % fat levels of 1.0% (±0.0%), and 0.7% (±0.1%) for Sawtooth-reared presmolts planted on July 31, 2000 and Sawtooth-reared presmolts planted on October 11, 2000, respectively. No Eagle-reared presmolts (from July 11, 2000 plants) were captured and sampled in 2001. Sawtooth-reared fish planted as presmolts in July and October averaged 5.6 g and 11.4 g, respectively, when captured and sampled in May 2001. Alturas Lake wild/natural smolts captured and sampled in May 2001 exhibited a mean percent fat level of 1.0% (±0.0%) and averaged 5.8 g.

Year 2001 out-migrants from Redfish Lake (planted as presmolts on October 11, 2000) exhibited a mean percent fat level of 3.1% (±2.0%). Fish from this release group captured and sampled in May 2001 averaged 13.8 g.

Eyed Egg and Fish Transfers

In all cases, the required State transfer permits were acquired before shipping. Specific details, by date, for all transfers are described below.

On November 14, 21, and 29, 2001, approximately 435 eyed-eggs from broodstock crosses were transferred from the Eagle Fish Hatchery to the NMFS Burley Creek Fish Hatchery. Fish that mature as a result of this transfer will be incorporated in future NMFS spawning designs.

On November 14, 19, 21, and 29, 2001, approximately 116,600 eyed-eggs from production crosses were transferred from the Eagle Fish Hatchery to the Sawtooth Fish Hatchery. Fish that result from this transfer will be used to fill spring 2003 smolt release strategies.

On October 25, 2001, milt harvested from seven brood year 1999 and two brood year 1998 sockeye salmon was transferred from Eagle Fish Hatchery to the NMFS Burley Creek Fish Hatchery to accommodate spawning needs.

On September 9 and 10, 2001, NMFS transferred 66 BY97 adults to Redfish Lake to be released for volitional spawning. One mortality was associated with the transportation.

In 2001, production eggs generated by NMFS were all transferred to the Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery. Approximately 90,222 were transferred between November 20 and December 20, 2001 (see NMFS annual report to BPA for more details).

Eyed Egg and Fish Reintroductions

Pursuant to Special Condition B9 Requirement D3 of Permit No. 1120, IDFG received authorization from NMFS to carry out the following production releases of sockeye salmon in 2001 (Table 7). All sockeye salmon released were adipose fin-clipped.

Smolt Releases

Age-1 sockeye salmon smolts (BY99) were released into Redfish Lake Creek (13,374) below the Redfish Lake Creek trap and (541) above the trap on May 2, 2001. The mean weight at release was 49.3 grams. All smolts were reared at Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery. All smolts released were adipose-clipped and coded wire-tagged. One thousand of the smolts were PIT tagged.

Adult Releases

Maturing adult sockeye salmon were released to Redfish Lake in September 2001 for volitional spawning. On September 9 and 10, 33 and 32 (65 total) NMFS Manchester Marine Laboratory hatchery-reared BY97 adults (mean weight 2,522.0 grams) were released. Efforts were made to release fish of equal sex ratios. Due to a lack of sexual dimorphism, sex ratios could not be positively determined. Fourteen anadromous adults (seven females and seven males), mean weight of 1,500.0 grams, were released on September 10, 2001.

Presmolt Releases

Presmolt direct lake releases to Stanley Basin lakes were conducted in July and October 2001 at midlake (pelagic) locations with the aid of a release barge on loan to IDFG from NMFS. All presmolts were from brood year 2000 and were reared at either Eagle Fish Hatchery or Sawtooth Fish Hatchery. On July 27, Alturas Lake received 3,064 presmolts and Pettit Lake received 3,059 presmolts reared at the Eagle Fish Hatchery. This group was adipose/left ventral fin-clipped and had a mean weight of 14.4 grams. On July 31, Alturas Lake received an additional 3,059 presmolts and Pettit Lake received an additional 2,998 presmolts reared at the Sawtooth Fish Hatchery. Fish from this group were adipose/right ventral fin-clipped and had a mean weight of 4.0 grams. On October 8, Redfish Lake received 41,529 presmolts (mean weight 10.8 grams) released directly to the lake; on October 9, Alturas Lake received 5,990 presmolts (mean weight 14.0 grams), and Pettit Lake received 4,993 presmolts (mean weight 15.4 grams). All October direct release presmolts were reared at Sawtooth Fish Hatchery and were adipose fin-clipped. Redfish Lake net pen presmolts were hatched and reared at the Eagle Fish Hatchery. On June 18 through 22, 49,090 presmolts (mean weight 6.8 grams) were located

to net pens to be reared in Redfish Lake. On October 10, 41,474 presmolts (mean weight 30.0 g) were released from net pens. Net pen released presmolts were adipose/left ventral fin-clipped to differentiate this release group from the direct lake release group at out-migration.

Table 1. Summary of losses and magnitude of mortality for five captive sockeye salmon broodstocks reared at IDFG facilities in 2001.

	Broodstocks				
	BY97	**BY98**	**BY99**	**BY00**	**BY01**
Starting Inventory (January 1, 2001)	12	278[a]	377	515[b]	870[c]
Eyed-Egg to Fry					
Undetermined	na	na	na	38[d]	na
Mechanical Loss					
Handling	0	0	3	1	na
Jump-out	0	0	0	0	na
Human Error	0	0	0	1	na
Noninfectious					
Lymphosarcoma	0	1	0	0	na
Nephroblastoma	0	0	0	0	na
Other	1[e]	12[e]	28[e]	2[e]	na
Infectious					
Bacterial	0	0	0	1	na
Viral	0	0	0	0	na
Other	0	0	0	0	na
Maturation					
Mature Males	9	90	75	0	na
Mature Females	2	152	8	0	na
Other	0	0	0	0	na
Relocation					
Transferred In	0	0	0	0	na
Transferred Out	0	0	0	0	435[f]
Planted/Released	0	0	0	0	0
Ending Inventory (December 31, 2001)	0	23	271	472	435

[a] Starting inventory reflects an inventory adjustment made post-completion of the 2000 BPA Annual Report.
[b] December 2000 developing fry and egg numbers. Starting inventory reflects an inventory adjustment made post-completion of the 2000 BPA Annual Report.
[c] December 2001 developing fry and eyed-egg numbers.
[d] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.
[e] Includes culling associated with cultural abnormalities, and all undetermined, noninfectious mortality.
[f] Transferred from IDFG Eagle Fish Hatchery to NMFS for broodstock rearing.

Table 2. Summary of losses and magnitude of mortality for two captive sockeye salmon production groups reared at IDFG facilities in 2001.

	Production Groups	
	BY00	**BY01**
Starting Inventory (January 1, 2001)	173,195[a]	116,600[b]
Eyed-Egg to Fry		
Undetermined	13,475[c]	na
Mechanical Loss		
Handling	14	na
Jump-out	0	na
Human Error	0	na
Noninfectious		
Lymphosarcoma	0	na
Other	12,088[d]	na
Infectious		
Bacterial	2,601	na
Viral	0	na
Other	0	na
Maturation		
Mature Males	0	na
Mature Females	0	na
Other	0	na
Relocation		
Transferred In	0	0
Transferred Out	0	0
Planted/Released	106,166	0
Ending Inventory (December 31, 2001)	38,851	116,600

[a] December 2000 developing fry and eyed-egg numbers.
[b] December 2001 eyed-egg numbers. All eggs were transferred from Eagle to Sawtooth Fish Hatchery.
[c] Typical egg to fry mortality includes nonhatching eggs, abnormal fry, and swim-up loss.
[d] Includes culling associated with cultural abnormalities and all undetermined, noninfectious mortality.

Table 3. Year 2001 anadromous sockeye salmon adult return summary.

Summary Category	Total Number Trapped	Number Trapped at Redfish Lake Cr.	Number Trapped at Sawtooth Hatchery
All Anadromous Adults	23	16	8
Anadromous Males	17	12	5
Anadromous Females	6	3	3
Unmarked Adults[a]	4	4	0
Adipose-Clipped Adults[b]	17	10	7
Adipose-Clipped and Left Ventral-Clipped Adults[c]	2	1	1

[a] Unmarked adults are presumably the result of eyed-egg and prespawn adult release strategies conducted in Redfish Lake in 1997. Unmarked adults could also be progeny of Redfish Lake residual sockeye salmon.

[b] Adipose-clipped adults are the result of presmolt and smolt release strategies conducted in 1998 and 1999, respectively. All juveniles released with an adipose clip (only) were reared at IDFG facilities.

[c] Adipose and left ventral-clipped adults are the result of smolt releases conducted in 1998. All juveniles released with adipose and left ventral clips were reared at the Oregon Department of Fish and Wildlife's Bonneville Fish Hatchery.

Table 4. Summary information for 2001 sockeye salmon spawning activities at Eagle Fish Hatchery.

Spawning Cross*		No. of Green Eggs Taken	No. of Eyed-Eggs	Mean Egg Survival to Eyed Stage	Median Egg Survival to Eyed Stage
Female	Male				
ANH01	BY98	2,724	1,877	68.9%	86.7%
ANH01	BY99	2,650	1,322	49.8%	49.8%
BY98	ANH01	43,033	19,893	46.2%	54.5%
BY98	BY98	25,138	11,386	45.2%	41.3%
BY98	BY99	208,889	83,643	40.0%	29.5%
	TOTALS	**282,434**	**118,121**	**42.0%**	**35.4%**

Note: * ANH01 refers to year 2001 anadromous sockeye salmon.
BY99 refers to captive adults produced in spawn year 1998.
BY99 refers to captive adults produced in spawn year 1999.

Table 5. Parent family and number of eyed-eggs retained for brood year 2001 captive broodstock development at Eagle Fish Hatchery.

Family Cross*		No. of Eyed-eggs Retained for Eagle Broodstock
Female	**Male**	
ANH01 H9	BY99	48
ANH01 H25	BY99	48
ANH01 H25	BY98	48
BY98	ANH01 H9	115
BY98	ANH01 H25	22
BY98	BY99	154
	TOTAL	**435**

Note: * ANH01 refers to year 2001 anadromous sockeye salmon.
ANH01 H9 refers to female mitochondrial haplotype "H9."
ANH01 H25 refers to female mitochondrial haplotype "H25."
BY98 refers to captive adults produced in spawn year 1998.
BY99 refers to captive adults produced in spawn year 1999.

Table 6. Year 2001 juvenile sockeye salmon and kokanee proximate body analysis summary. Redfish Lake Creek weir = RFL; Alturas Lake Creek screw trap = ALT; and Pettit Lake Creek weir = PET. Ad refers to adipose fin-clip; Lv refers to left ventral fin-clip; and Rv refers to right ventral fin-clip.

Sample Date	Sample Location	Description of Fish Sampled	Number Sampled	Mean Wt. (g)	Mean FL (mm)	Mean % Fat Dry Wt.
5/16/2001	RFL Weir	Hatchery-produced out-migrants (Ad only)	20	13.8	116.4	3.1 ± 2.1
5/16/2001	RFL Weir	Bonneville out-migrant	1	57.8	188	Pending
5/17/2001	ALT Screw Trap	Hatchery-produced out-migrants (Ad only)	10	11.4	115.0	0.7 ± 0.1
5/17/2001	ALT Screw Trap	Hatchery-produced out-migrants (Ad/Lv)	2	5.6	92.0	1.0 ± 0.0
5/17/2001	ALT Screw Trap	Wild/Natural out-migrants	8	5.8	92.3	1.0 ± 0.0
5/17/2001	PET Trap	Hatchery-produced out-migrants (Ad only)	13	19.8	131.8	5.9 ± 1.0
5/17/2001	PET Trap	Hatchery-produced out-migrants (Ad/Lv)	15	18.9	127.2	6.8 ± 1.5
5/17/2001	PET Trap	Hatchery-produced out-migrants (Ad/Rv)	11	15.2	119.3	2.6 ± 1.2
6/28/2001	Eagle Fish Hatchery	Net Pen fish at introduction to pens (Ad/Lv)	20	9.9	98.3	7.2 ± 1.2
7/26/2001	Eagle Fish Hatchery	Hatchery presmolts (Ad/Lv)	20	14.2	110	6.2 ± 1.2
7/30/2001	Sawtooth Fish Hatchery	Hatchery presmolts (Ad/Rv)	20	3.6	73	10.5 ± 5.1
8/1/2001	Eagle Fish Hatchery	Net Pen fish mid season (Ad/Lv)	20	14.5	120.6	5.5 ± 2.1
10/8/2001	Eagle Fish Hatchery	Net Pen fish at release (Ad/Lv)	20	24.7	128.9	13.3 ± 2.4
10/8/2001	Sawtooth Fish Hatchery	Hatchery presmolts (Ad only)	20	13.8	110.7	12.0 ± 2.0
9/17/2001	Redfish Lake	Trawl kokanee-age-0	10	75.9	4.4	Pending
9/17/2001	Redfish Lake	Trawl kokanee-age-1	1	107	12.2	Pending
9/18/2001	Pettit Lake	Trawl kokanee-age	12	178.5	60.2	Pending
9/19/2001	Alturas Lake	Trawl kokanee-age-0	4	51.8	1.0	Pending
9/19/2001	Alturas Lake	Trawl kokanee-age-1	7	76.1	3.7	Pending
9/19/2001	Alturas Lake	Trawl kokanee-age-2	5	119.2	15.2	Pending
9/19/2001	Alturas Lake	Trawl kokanee-age-3	1	159.0	28.4	Pending
Jun-01	Redfish Lake	Hook and line caught kokanee	20	na	na	Pending
Jun-01	Alturas Lake	Hook and line caught kokanee	20	na	na	Pending

Table 7. Sockeye salmon releases made to Sawtooth Basin waters in 2001.

Release Location	Strategy (Brood Year)	Release Date	Number Released	Number PIT-Tagged	Marks	Release Weight (g)	Rearing Location
Redfish Lake Creek (downstream of weir)	smolt (1999)	05/02/01	13,915	1000	Ad[a]/CWT	49.4	Bonneville Fish Hatchery
Alturas Lake (direct lake)	presmolt (2000)	07/27/01	3,064	—	Ad/Lv[b]	14.5	IDFG Eagle Fish Hatchery
	(2000)	07/31/01	3,059	—	Ad/Rv[c]	4.0	IDFG Sawtooth Fish Hatchery
	(2000)	10/09/01	5,990	—	Ad only	14.0	IDFG Sawtooth Fish Hatchery
Pettit Lake (direct lake)	presmolt (2000)	07/27/0	3,059	—	Ad/Lv	14.4	IDFG Eagle Fish Hatchery
	(2000)	10/08/01	4,993	—	Ad only	15.4	IDFG Sawtooth Fish Hatchery
Redfish Lake (direct lake)	presmolt (2000)	10/08/01	41,529	—	Ad only	10.8	IDFG Sawtooth Fish Hatchery
Redfish Lake (net pen)	presmolt (2000)	10/10/01	41,474	—	Ad/Lv	994.0	IDFG Hatchery/IDFG net pens
Redfish Lake	adult (1997)	09/09/01	33	—	None	2522.2	NMFS Manchester Marine Laboratory
	(1999)	07/31/00	32	—	None	2522.2	NMFS Manchester Marine Laboratory
	(1999)	10/11/00	14	—	None and Ad[e]	1500.0	Anadromous return

[a] Ad refers to adipose fin-clip.
[b] Lv refers to left ventral fin-clip.
[c] Rv refers to right ventral fin-clip.
[d] Only the smolts for the 2001 release year were PIT tagged. Additional lake out-migrants will be PIT tagged during trapping activities in 2002.
[e] Four anadromous fish did not have any marks; ten anadromous fish were adipose fin-clipped.

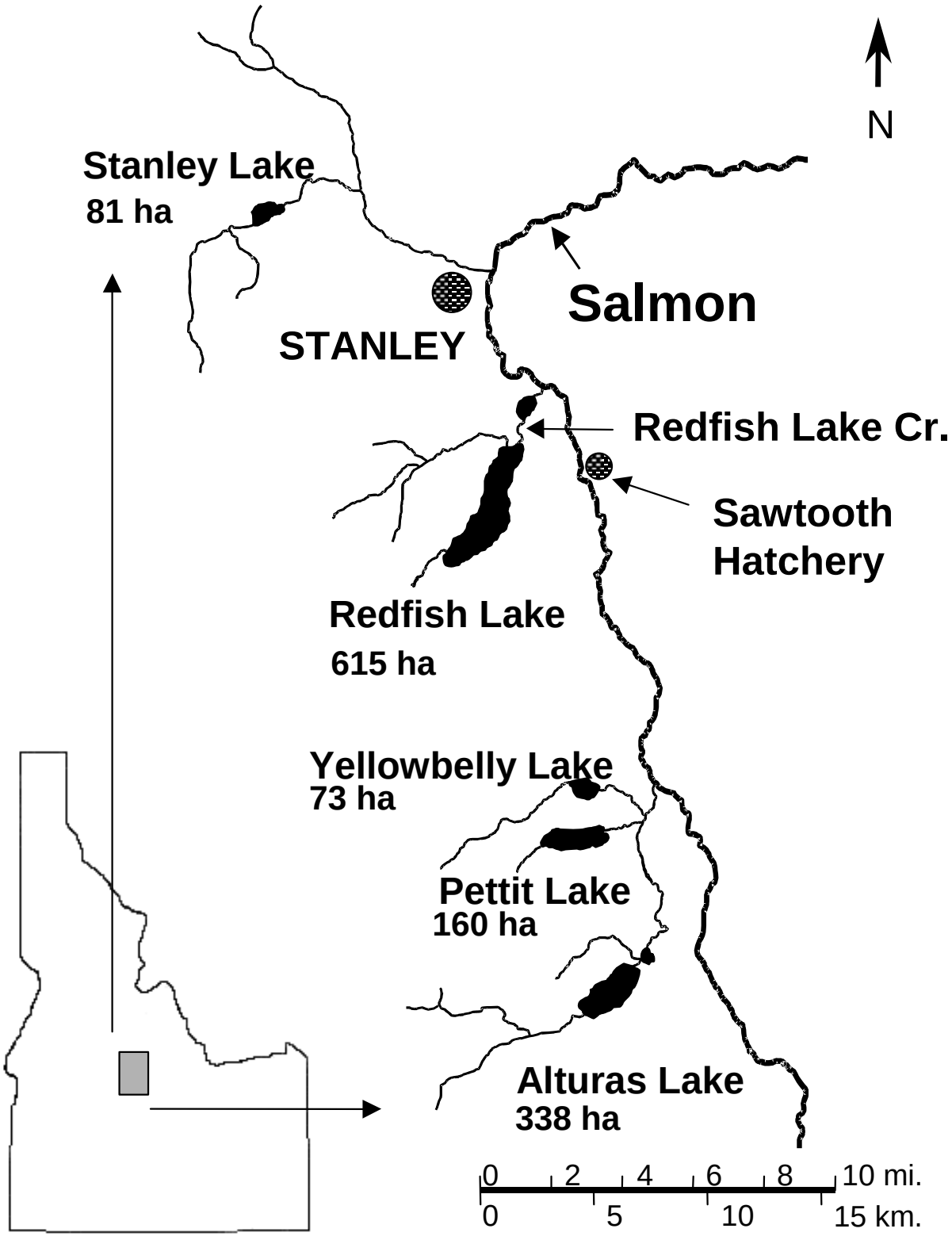

Figure 1. Stanley Basin study area.

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APPENDICES

Appendix A. Year 2001 spawning matrix memo.

IDAHO DEPARTMENT OF FISH AND GAME
EAGLE FISH HATCHERY
1800 Trout Road, Eagle ID 83616
Phone (208) 939-4114, Fax (208) 939 2415

September 30, 2001

M E M O R A N D U M

To: **SBSTOC Cooperators**
NMFS Northwest Fisheries Science Center

From: **Paul Kline**

Subject: **Proposed 2001 sockeye salmon spawning design**

Eagle Fish Hatchery (IDFG) and Burley Creek Fish Hatchery (NMFS) circumstances for 2001 are similar and are to be discussed together.

The following full-term hatchery adults are maturing at IDFG and NMFS facilities:

1) BY98—Three primary culture groups were developed in 1998 to meet future broodstock needs. The first group (produced at the NMFS Big Beef Creek Hatchery) was developed from second generation females (ANBY91) produced from the four anadromous adults that returned to Redfish Lake Creek in 1991 (AN91) and the single anadromous male that returned to Redfish Lake Creek in 1998 (AN98). The second culture group was developed from first generation females (ANBY96) produced from the single female that returned to Redfish Lake Creek in 1996 (AN96). Males used for spawn crosses included first generation males (ANBY94) produced from the single female that returned to Redfish Lake Creek in 1994 (AN94), the single anadromous male that returned to Redfish Lake Creek in 1998 (AN98), and cryopreserved milt from first generation progeny (OMBY93) of female 1991 Redfish Lake out-migrants (OM91) and the six male sockeye salmon that returned to Redfish Lake Creek in 1993 (AN93). The third culture group was developed from first generation females and males (ANBY96) produced from the single female that returned to Redfish Lake Creek in 1996 (AN96). **In general terms—this broodstock was developed from 1991, 1993, 1994, 1996, and 1998 anadromous sockeye salmon.**

2) BY99—Progeny from spawn activities conducted in 1999 including the following lineage-specific crosses (female x male): 1) ANBY96 x BY97, 2) ANBY96 x BY96, 3) ANBY96 x ANBY96, 4) BY96 x BY97, 5) BY96 x ANBY96, 6) ANBY96 x ANH99, 7) BY96 x ANH99, 8) ANH99 x BY97, 9) ANH99 x ANH99, 10) ANH99 x ANBY96 and 11) ANH99 x AN98 cryo. **In general terms—this broodstock was developed from 1993, 1996, and 1999 anadromous sockeye salmon in addition to cryopreserved milt.**

In addition to BY98 and BY99 adults, the Eagle Fish Hatchery is currently holding nine anadromous adults that returned to the program in 2001. These fish are described below:

1) ANH01 anadromous adults—two females and six males were retained for spawning in 2001. Selection of these nine adults was based on genetic information developed by the University of Idaho. ANH01 adults retained include two age-five males, seven age-four

males, and two age-four females. Age-five males originated from the Bonneville hatchery smolt group released in 1998. These two males are second generation progeny of AN93 female and male parents. Crosses were performed to avoid relatedness (2 anadromous females and 6 males returned to the program in 1993). Age-four adults (produced in spawn year 1997) are progeny of ANBY94 F_1 females x BY93 F_1 males.

In addition to BY98 and BY99 adults, the Burley Creek Hatchery is currently holding BY97 captive adult sockeye salmon (seawater rearing history). These adults are described below:

1) BY97 broodstock adults are progeny of ANBY94 F_1 females x cryopreserved milt from OM91, OM92, and AN92 males. **In general, this broodstock was developed using 1991, 1993, and 1994 anadromous sockeye salmon and cryopreserved milt from 1991 and 1992 out-migrants.**

PROPOSED CROSSES

Brood year 1998 represents the primary spawning component in 2001. Because most BY98 adults at both facilities share a common male parent, preferred crosses will involve out-crossing BY98 females with BY97, BY99, and ANH01 males. In addition, cryopreserved milt from unique program males could be used in the spawning design to expand the diversity of the 2001 broodstock.

In some cases, out-crossing brood years will not completely eliminate all inbreeding risk. In such cases, PIT tag information will be used to select individuals from unrelated subfamilies (across brood years).

The following table identifies preferred crosses for spawn year 2001:

Year 2001 desirability matrix

FEMALES		MALES FIRST PREFERENCE	SECOND PREFERENCE	THIRD PREFERENCE	Comment
ANH01(age-4)	x	ANH01(age-5)			1
ANH01(age-4)	x	CYRO			1
ANH01(age-4)	x	BY99			1
ANH01(age-4)	x		BY97		2
ANH01(age-4)	x		BY98		2
ANH01(age-4)	x			BY96	3
ANH01(age-4)	x			ANH01(age-4)	3
BY97	x	CRYO			1
BY97	x	ANH01(age-5)			1
BY97	x		BY98		2
BY97	x		BY99		2
BY97	x		ANH01(age-4)		2
BY97	x			BY97	3
BY98	x	CRYO			1
BY98	x	ANH01(age-5)			1
BY98	x		ANH01(age-4)		2
BY98	x		BY97		2
BY98	x		BY99		2
BY98	x			BY98	3
BY99	x	ANH01(age-4)			1
BY99	x	ANH01(age-5)			1
BY99	x	CRYO			1
BY99	x		BY97		2
BY99	x		BY98		2
BY99	x			BY99	3

(**Table recommendations the same when organized by male x female order)**

1) All crosses avoid inbreeding.
2) Possible inbreeding risk, use PIT-tag data to establish safe lineages to cross.
3) Greatest inbreeding risk, more difficult to identify—avoid crosses if possible.

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